Space Weather Technical Forecast

Issued on Monday, 10 June 2024 at 12:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: M-flares (R1-R2 radio blackouts) initially likely, slight chance of X-flares (R3 blackout), risk declining through the period. Increase in solar radiation likely, slight chance of S3/Strong radiation storm. Slight chance of G1/Minor storms on Day 1 (10 June).

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity is High with an X1.5 flare peaking at 10/1108 UTC from AR3697 on the southwest limb.
There are now ten sunspot regions on the disc, with a faint new region developing in the northeast. The most active region is AR3697, but this has nearly rotated off the southwest limb and is no longer clearly visible. It will contribute to the flare risk for another 24 hours or so until it is well away from the west limb. AR3709 in the southeast will be the largest region once AR3697 is off the disc. It consists of a large leader spot with smaller spots around it. The remaining regions are mostly simple and stable at the present time. Some looping observed in SDO imagery suggests a new region to rotate onto the southeast limb in the next 24 hours. No new Earth-bound CMEs were observed in the period.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by ACE at L1, showed waning high speed stream (HSS) influence. Wind speeds were initially slightly elevated, around 420 km/s, easing to background levels near 360 km/s. The density was average or below throughout. The IMF (Interplanetary Magnetic Field) was weak at 6nT or below. The north-south component, Bz, varied weakly between +4/-5nT. The phi angle fluctuated a little but was mainly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1 to 2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 continued to ease below the S1/Minor radiation storm level. 100MeV protons returned to background levels.
High energy electron flux (greater than 2MeV) observed by GOES16 was at background levels, with the associated 24-hour fluence well below Active. Observed fluence at 10/0000 UTC was 1.17e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: M-flares are initially considered to be likely with a slight chance of further X-flares, mainly from AR3697. The risk reduces through Day 2 (11 June) as AR3697 rotates away from the west limb.

Solar Wind / Geomagnetic Activity: The CME which was modelled by MOSWOC Enlil with a likely arrival time at Earth in the UTC morning of Day 1 (10 June) appears to have arrived at the STEREO-A spacecraft at 10/0300 UTC, which means it would have been expected to have arrived at Earth by now. As such, it is considered more likely that this has missed. No other new Earth directed CMEs have been seen in available coronagraph imagery. Solar winds have now eased to background levels after an enhancement from CH42/+ in the northwest disc. A further slight enhancement is possible from the small CH44/- in south centre disc later on Day 4 (13

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

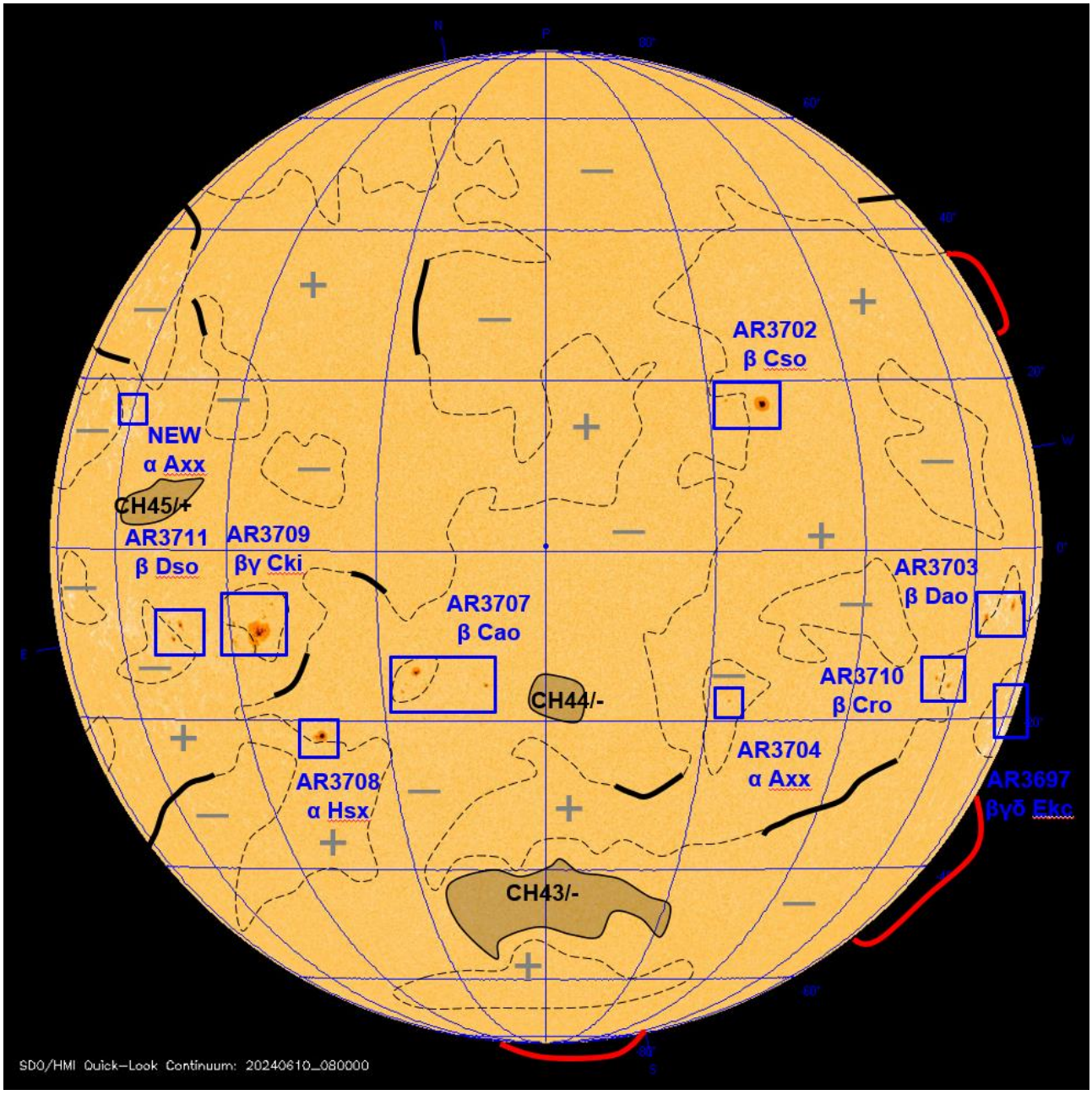
June).
Geomagnetic activity is likely to be mostly Quiet to Unsettled. Any enhancement associated with the 08 June CME is looking less likely now, but should it arrive then there is a risk of Active to G1/Minor Storm conditions on Day 1, perhaps lingering into Day 2 (10-11 June). There is also a chance of Unsettled to Active intervals on Day 4 with any weak high speed stream influence.

Energetic Particles / Solar Radiation: High energy proton flux is now below S1/Minor radiation storm levels after the recent S3/Strong enhancement. A further enhancement is likely after the recent X-flare, with a chance of exceeding S3 again, before the risk reduces later in the period as AR3697 rotates away.
High energy electron flux is forecast to persist at predominantly background levels, and the associated 24-hour fluence forecast should remain below the Active threshold.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 1. Solar Analysis Valid 10/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms:

The M9.7 flare from AR3697 at 08/0149UTC in the southwestern disc generated a CME which was modelled by MOSWOC Enlil with a likely arrival time at Earth in the UTC morning of Day 1 (10 June). Most of the ejecta was directed south and west of the Sun-Earth line, and the CME appears to have arrived at the STEREO-A spacecraft at 10/0300 UTC. Although STEREO is located slightly inside of and ahead of Earth's orbit, the CME would have been expected to have arrived at Earth by now. As such, it is considered more likely that this has missed. No other new Earth directed CMEs have been seen in available coronagraph imagery.
Solar winds have now eased to background levels after an enhancement from CH42/+ in the northwest disc. A further slight enhancement is possible from the small CH44/- in south centre disc later on Day 4 (13 June). However, this is expected to be minor and with a limited geomagnetic response, given the time of year.

Geomagnetic activity is likely to be mostly Quiet to Unsettled. Any enhancement associated with the 08 June CME is looking less likely now, but should it arrive then there is a risk of Active to G1/Minor Storm conditions on Day 1, perhaps lingering into Day 2 (10-11 June). There is also a chance of Unsettled to Active intervals on Day 4 with any weak high speed stream influence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	5	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

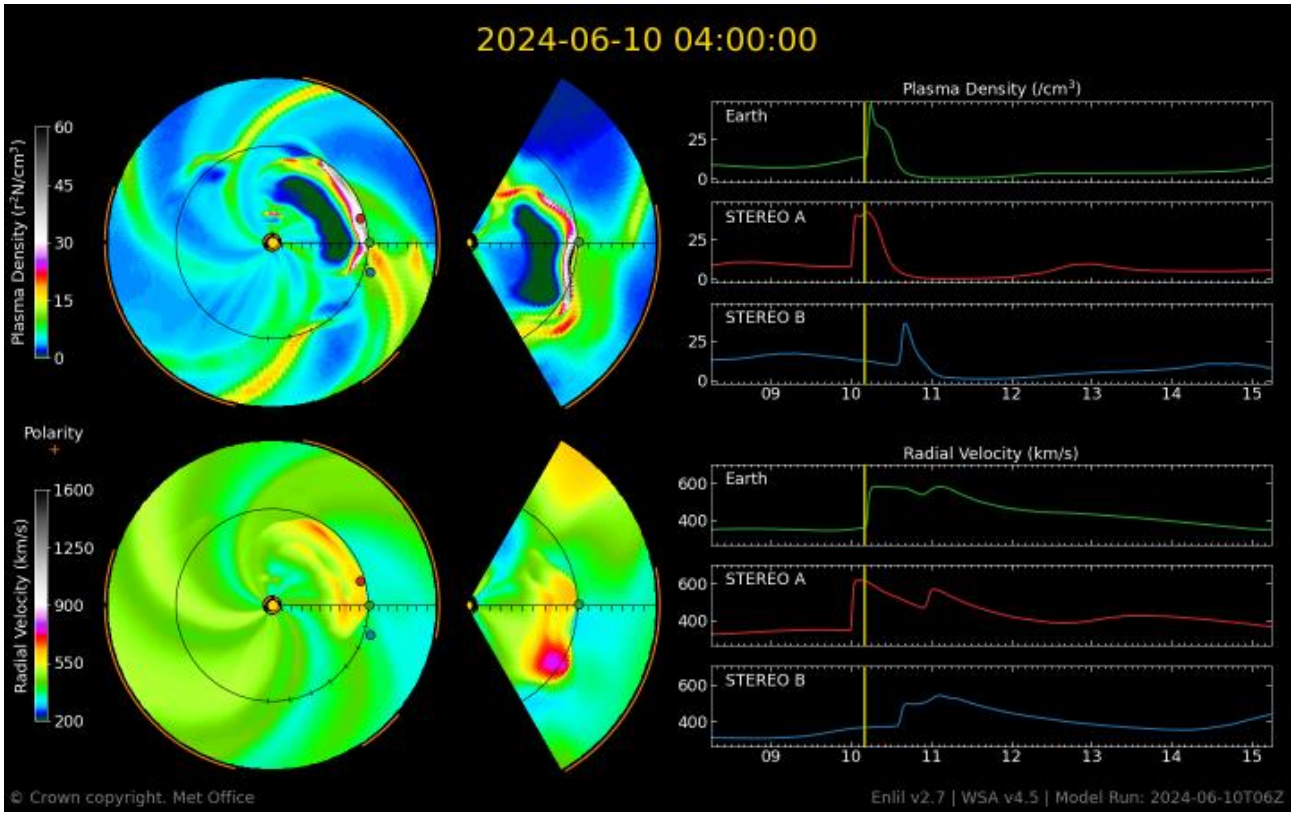
Geomagnetic Activity - Earthbound Coronal Mass Ejections

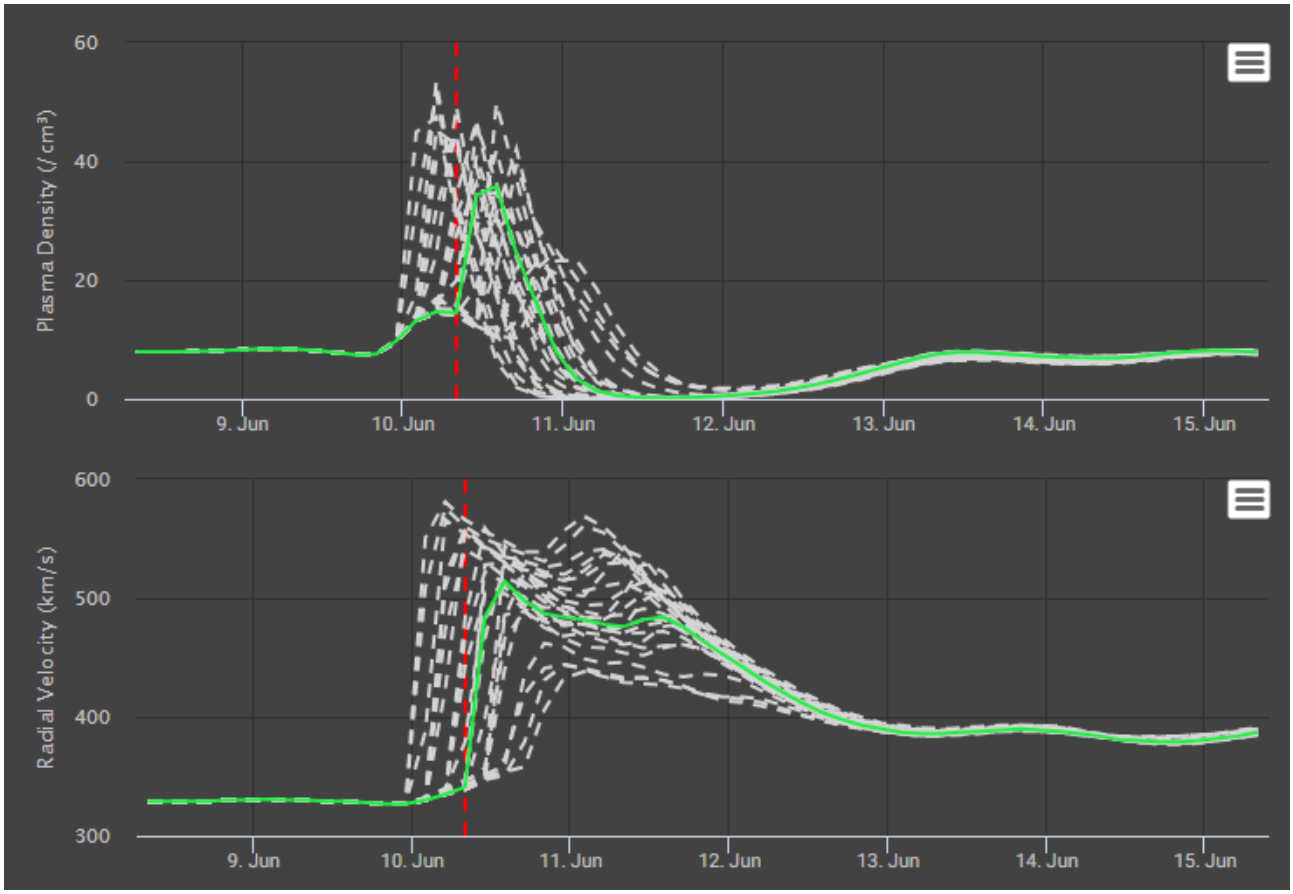
Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
08/0439	Partial	AR3697	SW	1154 km/s	10/0600 UTC	Now considered more likely to have missed.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 2: MOSWOC Enlil and ensemble. It shows the CME which was forecast to arrive today, but evidence from STEREO-A suggests this may have missed Earth.





Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
Solar activity is High with an X1.5 flare peaking at 10/1108 UTC from AR3697 on the southwest limb.

There are now ten sunspot regions on the disc, with a faint new region developing in the northeast. The most active region is AR3697, but this has nearly rotated off the southwest limb and is no longer clearly visible. It will contribute to the flare risk for another 24 hours or so until it is well away from the west limb. AR3709 in the southeast will be the largest region once AR3697 is off the disc. It consists of a large leader spot with smaller spots around it. The remaining regions are mostly simple and stable at the present time. Some looping observed in SDO imagery suggests a new region to rotate onto the southeast limb in the next 24 hours.

M-flares are initially considered to be likely with a slight chance of further X-flares, mainly from AR3697. The risk reduces through Day 2 (11 June) as AR3697 rotates away from the west limb.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	70	50	30	30
Very Active	R3 to R5 X Class	Yes	20	15	5	5

Figure 3: X-ray flux at GOES16 and 18, showing the recent X-flare from AR3697.

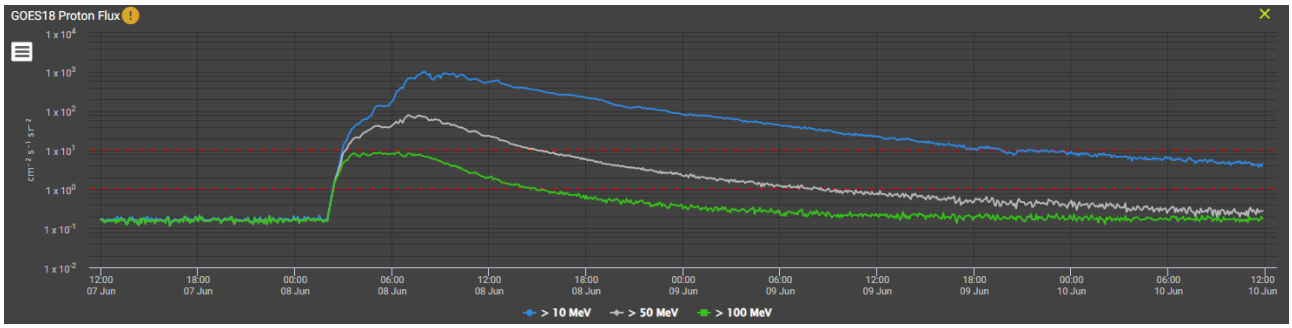
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):
AR3697 is currently in a prime position to deliver further S-scale enhancements. The recent X-flare from this region means that it is likely proton flux will once again reach above S1, with a slight chance of exceeding S3 again in the coming hours. The risk from this region then reduces once it rotates well away from the west limb, during Days 3-4 (12-13 June).

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	60	50	30	10
Very Active	**≥ S3 ***	No	20	15	5	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Proton flux at GOES18 over the last three days, showing the enhancement on 08 June and the gradual subsequent decline. A further enhancement is probable once again after the recent X-flare.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

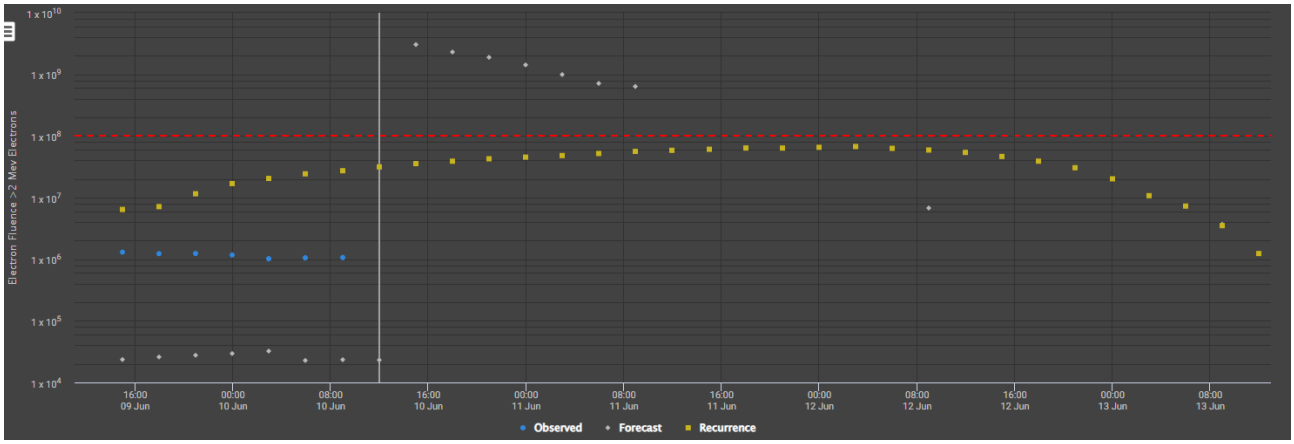
© Crown Copyright 2024. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):
The high energy electron flux is likely to persist at background levels for much of this period, with any response to the recent high speed stream looking unlikely given the lack of response now that wind speeds have returned to background levels.

MOSWOC REFM output has been forecasting an increase in fluence above the Active (1e8 integrated pfu) level in the next 24 hours, but this appears unlikely to occur, with fluence expected to remain below Active through this period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM is currently forecasting an increase in fluence, but this is considered unlikely given the lack of response to the recent high speed stream now the wind speeds have eased to background levels.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.